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MADROÑO

A WEST AMERICAN JOURNAL OF BOTANY

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THE STRUCTURE OF MONOTROPSIS AND THE CLASSIFICATION OF THE MONOTROPOIDEAE

Herbert F. Copeland

The original observations here to be presented refer exclusively to *Monotropsis odorata,* and are based entirely on material furnished by Mr. Willman Spawn, of Washington, D. C., to whom I am most cordially grateful. These observations, in connection with my previous studies (3, 4, 5, 6) have led me to certain conclusions as to the natural arrangement in tribes of the genera of Monotropoideae. I follow the statement of observations, therefore, with a suggested solution to a problem which has engaged, among other authorities, Gray (11), Drude (9), Andres (1), and Domin (7). The arrangement proposed is, of course, tentative and subject to amendment; it is based on a body of knowledge which could have been extended by further study; but such is the nature of all scientific hypotheses.

For access to some of the literature, I am indebted to the California State Library. The borrowing and lending among libraries, which are so helpful to the student, serve him with so little trouble to himself that he can easily overlook his obligation to the system and to the libraries which participate in it.

Dr. Katherine Esau, of the University of California at Davis, has helped me, as noted below, to understand the phloem.

At this stage in my studies of the Monotropoideae, I must not fail to acknowledge a considerable debt to Dr. W. L. Jepson, at whose suggestion I first undertook them. Correspondence with Dr. H. Andres, with Dr. W. H. Camp, and with Mr. Willman Spawn has been a constant source of information and of inspiration.

The Nomenclature and Distribution of Monotropsis

Monotropsis, the third in order of discovery among the genera of Monotropoideae, includes three species, all confined to the southeastern United States. The nomenclature and geographic distribution, compiled largely from the writings of Small (23, 24, 25) are as follows:

Monotropsis Schweinitz *ex* Elliott Fl. S. Car. and Ga. 1: 478. 1817. *Schweinitzia* Elliott *apud* Elliott l. c. *Cryptophila* Wolf in Amer. Midland Nat. 8: 115. 1922.

1. Monotropsis odorata Elliott, *op. cit.,* p. 479. *Schweinitzea* [!] *odorata* Rafinesque in Amer. Monthly Mag. 3: 99. 1818. *Schweinitzia caroliniana* G. Don, Gen. Syst. 3: 867. 1834. *Cryptophila pudica* Wolf, *op. cit.,* p. 117. Maryland to Georgia and Alabama, in and near the mountains; type locality, Stokes County, North Carolina.

Madroño, Vol. 5, pp. 105–136. October 16, 1939.

2. Monotropsis Reynoldsiae Heller, Cat. N. Am. Pl. 5. 1898. *Schweinitzia Reynoldsiae* Gray in Proc. Am. Acad. 20: 301. 1885. Florida; type locality, near St. Augustine.

3. Monotropsis Lehmaniae Burnham in Torreya 6: 235. 1906. North Carolina; type locality, Roaring Gap on the Blue Ridge.

In most of the standard accounts of the Monotropoideae, the generic name *Schweinitzia* is used. This name originated on the same page as *Monotropsis,* where Elliott included the following remark: "I hope, however, that instead of the compound name by which Mr. Schweinitz has designated this genus, to which Botanical critics will object, the name of Schweinitzia may be given to it. . . ." The generic description, nevertheless, is under the heading of *Monotropsis;* the specific epithet "1. Odorata" on the next page must be held to be published under *Monotropsis;* no binomial under *Schweinitzia* can be recognized as published by Elliott. *Schweinitzia* was treated as valid in two publications of the following year, respectively by Nuttall (20) and by Rafinesque (22); it was the latter who first made the familiar combination *Schweinitzia odorata.*

The authors just mentioned were nearer in time to Linnaeus than to us, and observed certain usages of Linnaeus which we have abandoned. Linnaeus treated the relative antiquity of names as of little consequence. One of his services to science—his greatest service, in the unappreciative view of Greene (13)—was a purge, a veritable massacre, of such names as *Lilio-Narcissus, Cyperoides,* and *Chamaerhododendros.* He made good form a postulate, and seems to have assumed that this feature of his system would be of material influence in keeping it in use. In view of the Linnaean precedent, Elliott and Nuttall, Rafinesque and Gray, felt no compulsion to use any name which seemed to them in poor taste. Some fifty years after the name of *Schweinitzia* came into use, an international botanical congress adopted a code according to which priority takes precedence of usage and good taste; and after some twenty years more, a new purge of names, guided by the newer postulate, was carried through. This was by many felt to be an unprovoked outrage. The objectors, however, found themselves entrapped; only to a limited extent has it been possible to avoid using the names put forward by Otto Kuntze. It was he (19, p. 391) who resurrected *Monotropsis.* We of the present time can find no excuse not to follow him; and to our taste, one name seems hardly worse than the other.

The Reverend W. Wolf (26) studied *Monotropsis odorata,* as it occurs at St. Bernard, Cullman County, in northern Alabama, for some twenty years before he published it as new genus and species, *Cryptophila pudica:* In the early stages of his work, he had recognized the true identity of the plant; it was the writings of Gray (11), which describe the fruit as a five-celled capsule, that misled him into supposing he had something new. Small (23, 24) had erred as Gray had, but he was not deceived by the revelation of the true characters of the ovary and fruit; he presently (25) reduced Wolf's names. The observations of Wolf were extensive and accurate; in matters of gross morphology, what follows is in part confirmation of his work, and in part stated on his authority.

MATERIAL

The material furnished by Mr. Spawn consists of three flowering shoots of *Monotropsis odorata,* with roots, collected in Maryland in April of 1938; and of a juvenile shoot and a fruit collected late in July of the same year. These objects had been fixed in Bouin's fluid, and came to me preserved in alcohol; I have found them very well prepared.

THE ROOT SYSTEM

The root system is the permanent member of the plant. It shows, on sectioning, scattered scraps of mycorrhiza on the surface; it cannot be said to be generally covered by a heavy layer of mycorrhiza.

The diameter of roots varies from about 0.2 mm. to about 1.0 mm. A longitudinal section of one of the smaller ones (I have been unable to follow any of the larger ones to the tip) shows a very feebly developed cap, formed by periclinal divisions of cells of the dermatogen, which is continuous over the tip within the cap (Pl. 9, fig. 2). The distal end of the plerome appears to be separated from the dermatogen by a single layer of cells belonging to the periblem.

In the mature region, a small root such as this would show two strands of xylem (Pl. 9, fig. 3); larger ones show from three to five strands of xylem (Pl. 9, figs. 4–6). Lignified conducting cells of the xylem are present in the centers of smaller roots; in larger roots, the cells in the center remain undifferentiated and constitute a pith. No cambial activity is recognizable. It has seemed possible to recognize the boundary between pericycle and cortex by a difference in the size of the parenchymatous cells, those of the pericycle being smaller; it has not been possible to recognize an endodermis differentiated by the presence of Casparian strips. Secondary roots and adventitious buds (Pl. 9, figs. 5, 6), the latter in much smaller numbers than the former, originate in the pericycle in the planes of the strands of xylem; each root bears, therefore, a number of rows of these equal to the number of strands of xylem in the stele.

THE SHOOT

The shoot, including the flowers and fruit, is totally glabrous.

Young shoots appear above ground during the summer or fall. The one which I have seen has the distal end turned aside to a right angle with the erect part, so as to lie parallel with the surface of the earth. When winter is past, this distal end, still in the same position, bears the flowers. Wolf explains that the first part of the shoot to emerge from the ground is not the tip but the middle: the shoot comes up like a bean seedling, as an arch. The arch unbends, but very slowly, so that the end of the shoot may scarcely be fully erect even in fruit. He explains further that the plant is normally sheltered among dead leaves, so as to be found only by raking even when, in fruit, it reaches its greatest height. He regards this shelter as necessary to the life of the plant, which perishes with the forests that furnish it.

My flowering material consists, as I have said, of three shoots. Two of these shoots sprang from opposite sides of a single root: one of them is shown (Pl. 9, fig. 1) the other having been removed. The leaves are spirally arranged obovate obtuse scales attached by the broad base. The details of the arrangement of leaves are inconstant; in order to express what has been seen, it seems expedient to conventionalize, for present purposes, the use of three terms. (a) If we stand above a horizontal root while facing away from its origin, we may designate its sides as right and left as they lie respectively beneath our right and left sides: this convention is the same that is applied to rivers. (b) Following Gray in the choice between the two possibilities, we may designate as a right spiral one which ascends in passing from opposite our left hand to opposite our right hand. (c) By an orthodox spiral, I mean an arrangement of leaves conforming to the familiar 1/2, 1/3, 2/5, etc., system. Now as to the shoots actually seen: of the two which stand upon a single root, the one on the right side shows a right orthodox spiral and the one on the left shows a left orthodox spiral; while the third shoot, alone on its root, shows a left heterodox (approximately 1/4) spiral. These are mere isolated observations; I do not know that anyone has studied the extent to which the phyllotactic arrangement of leaves is governed by the origin of the shoot which bears them.

Further study of the shoots showing orthodox spirals tended to confirm the doctrine that all orthodox spirals are identical, the apparent different divergences being functions of the extent to which the leaves are crowded. My analysis of the positions of bundles and leaves (Pl. 9, fig. 8) was prepared from the shoot showing a right spiral; as it was prepared with the aid of a compound microscope, the actual directions are reversed, and we have a representation of a left spiral. As we ascend the stem, numbering the leaves beyond any particular one which we designate as leaf zero, we find that leaf 3 falls a certain distance to the left of just above it, and leaf 5 a shorter distance to the right; leaf 8 to the left, but not so far as leaf 3, and leaf 13 to the right, but not so far as leaf 5. A longer stem would doubtless show leaf 21 again to the left and leaf 34 to the right. The actual deviation is an irrational fraction of a circle which has the property of giving the appearance of an early member of the series, 1/3 or 2/5, if the leaves are far apart, and a higher member, 8/21 or 13/34, if they are crowded.

Sections of the stem show an epidermis with a longitudinally striate cuticle and an internal mass of parenchyma, of cortex, pericycle, and pith, including many tanniniferous cells. Imbedded in the parenchyma is the single cylinder of separate vascular bundles. There is no sheath of fibers. One bundle runs out to each leaf, forking, as it leaves the stem, into three branches. The forking and anastomosis of the bundles which traverse the stem are altogether irregular, a most surprising feature to observe in connection with a perfectly regular arrangement of leaves (Pl. 9, fig. 7, modelled to a definite scale, and fig. 8, representing the internodes as of equal length and the cylinder as unrolled). Within the bundle (Pl. 10, fig. 9), the xylem includes on the side toward the pith a few spiral and annular elements; it consists for the most part of scalariform vessel elements with reticulate cross-walls tilted slightly away from horizontal. There is no cambium; no lateral growth takes place. In the anatomical features mentioned, *Monotropsis* is in good agreement with *Hypopitys* as described by Kamienski (17, 18). This author reported the end-walls of the sieve tubes as devoid of perforations: "Disons franchement que les tubes cribreux ainsi nommés, ne sont pas à proprement parler des tubes, car ils restent fermés par des cloisons transversales, de même qu'ils ne sont pas cribreux car leurs cloisons ne sont pas criblées." He furnished a figure to support this statement. My observations agreed in this point also with his; but I took the precaution of inviting Dr. Katherine Esau to examine my slides. She experienced no difficulty in finding typical sieve plates (Pl. 10, fig. 10); I (and likewise, no doubt, Kamienski) had been deceived by the abundant phloem parenchyma.

The Flower

The inflorescence is a dense raceme of but few flowers. Each pedicel stands in the axil of a bract and bears two bractlets. The flowers are mostly pendant. They are ordinarily pentamerous, but deviations from this condition are common. In my material, one of the terminal flowers is tetramerous, and several flowers, otherwise pentamerous, have a pistil of four carpels. Author after author, beginning with Elliott, has described the flowers as smelling like violets; Wolf describes them as smelling like cloves. The difficulty of describing odors is notorious; undoubtedly, Wolf is referring to the same scent as the other authors.

The sepals (Pl. 10, fig. 11) are separate. The corolla (Pl. 10, fig. 13) is sympetalous, campanulate; at the same time that the petals are laterally united, the base of each one is swollen out into a shallow sac or pocket. One inclines to interpret this sac as a device for the accumulation of nectar; possibly the nectar is held in place in the inverted flower by capillarity.

There are normally ten stamens. Using purely descriptive language, one may say that the filament is attached to the dorsal side of the anther, within which there is a single chamber opening through two dorsal-distal pores (Pl. 10, fig. 12). Dissection (Pl. 11, figs 16–21) reveals remnants of partitions by which, presumably, the interior of the young anther is divided into four chambers. In the anthers of most angiosperms, that internal wall which lies in a sagittal plane—the connective, separating the two lobes of the anther—is permanent; while in each lobe, the wall in a frontal plane, separating the two microsporangia of the lobe, breaks down before anthesis. In *Monotropsis,* on the other hand, the connective disappears except at the end toward the summit of the flower, between the pores; the frontal walls persist to a slightly greater depth.

I have seen no juvenile anthers. Gray (11) and Wolf account for them as borne in a horizontal position, and Wolf's figures show that the pores originate as slits at the outer ends, where the filaments are attached, each slit crossing the ends of the two microsporangia of one lobe. As the anthers mature, the ends originally inward turn downward (toward the base of the flower) while the pores come to face the summit of the flower. It may be concluded that the outer, apparently dorsal, surface of the mature anther is really ventral; the end toward the base of the flower is the distal end, and the pore-bearing end, facing the summit of the flower, is the proximal end.

The mature pollen grain (Pl. 11, fig. 22) has a thin exine, smooth except for two grooves lying in the same great circle. It contains two dissimilar nuclei. The larger is the generative nucleus; it is spheroidal and is imbedded in a clear space, the generative cell.

Within the bases of the filaments and surrounding the base of the pistil, there is a lobed nectary. Wolf calls attention to Rafinesque's erroneous statement, obviously a mistaken guess, "Stamina 10, a pair between each angle of the nectary." He proceeds to a descriptively correct account of the nectary as five-lobed, the lobes being opposite the petals and emarginate, with one stamen opposite each lobe and one between each pair of lobes. I would place upon the structure a slightly different interpretation: the nectary is ten-lobed; the lobes are in pairs, a pair clasping the base of each petalad stamen.

The pistil is flask-shaped, somewhat shorter than the corolla; the capitate stigma is not evidently lobed. A cross section of the ovary near the base (Pl. 11, fig. 23) shows five (or, often, four) separate chambers. One does not find a single placental mass projected from the axis into each chamber, but two; these are, of course, the margins of the carpels. At any level much above the base of the ovary, a cross section (Pl. 11, fig. 24) shows the two edges of each carpel completely separate from one another, so that the ovary is unilocular and the placentation parietal. The placentae, throughout the ovary, are densely covered with ovules. The placentae as seen in the upper part of the ovary—each placenta being the fused adjacent edges of two carpels—are continued upward as ridges projecting into the open style channel through which the interior of the ovary is in contact with the atmosphere (Pl. 11, fig. 25).

Sepals, petals, filaments, and the outer surfaces of ovary and style are covered by an epidermis bearing a striate cuticle, enclosing a parenchyma some cells of which are tanniniferous, much as in the stems. The anther wall appears to consist of a single layer of collapsed cells. In the neighborhood of the pores there is a distinct tissue evidently involved in dehiscence; its exact nature was not determined, but it appears to be an epidermis of large isodiametric cells which open the pores by contracting hygroscopically.

The vascular supply of each flower originates as one bundle of the cylinder of bundles in the rachis. In this part of the stem, the pericycle is recognizable by a slight differentiation of the cells, not extending to the formation of fibers. Each bundle which passes out to a flower is to be interpreted as a leaf trace completely fused with a branch trace. As it crosses the cortex it gives off a branch to the bract, and as it ascends the pedicel it gives off two branches, one to each bractlet. It enters the receptacle not as a smoothly cylindrical bundle but as a lobed mass which breaks up into four (more or less) main bundles of the flower. These give rise to the following six whorls of bundles in acropetal succession (Pl. 10, fig. 15): (1) a whorl of sepal bundles; (2) a whorl of petal bundles, alternating with the sepal bundles; (3) a whorl of petalad stamen bundles; (4) a whorl of sepalad stamen bundles; (5) a whorl of carpel dorsals, in the planes of the petal bundles; (6) a whorl a placental bundles, in the planes of the sepal bundles. The placental bundles are simply the continuations of the main bundles of the flower. All the bundles of the first five whorls arise either from the dorsal surfaces or from the sides of the main bundles, and leave no gaps; all of them depart at angles greater than 90°, that is, in directions approaching the basipetal. They presently bend and come into the acropetal direction, parallel to the main bundles. In entering the corolla, each petal bundle divides into three branches, of which the median one, the smallest, takes the longest course, following the contour of the sac, while the larger, lateral, bundles ascend past the sac. From the lowest part of the course of the carpel dorsals short obscure branches run out into the nectary. After ascending the walls of the ovary, the carpel dorsals ascend the walls of the style, following the thin strips between the ridges which project into the style channel.

They fade out in the stigma. The placental bundles fade out within the ovary.

The ovary wall is half a dozen cells thick. Its inner epidermis is a layer of elongate, slender cells bearing no cuticle, being indistinguishable except by their shape from the parenchyma of the wall. The epidermis of the placentae consists of rather large, thin-walled, somewhat densely staining cells (one of them is shown in Pl. 11, fig. 28). The inner epidermis of the style is of cells similar to these but elongate, parallel to the axis of the style. Just at the mouth of the style passage, there is some cuticulate epidermis; this cuticle does not extend over the stigmatic surface, being completely separate from the similar cuticle on the outside of the style. The stigmatic surface (Pl. 11, fig. 27) is of large columnar tanniniferous cells laterally in contact with one another; their end walls against the atmosphere appear to be thickened but not hardened, as if converted into some gelatinous material.

The ovules are the ordinary ovules of the Monotropoideae. They are anatropous, with an integument of two layers of cells, of which the outer shows an incipient accumulation of tannin. The nucellus is absent, having been absorbed, when the embryo sac is mature. The embryo sac consists of an egg, two synergids, an endosperm mother cell (in which the two polar nuclei may or may not have fused), and three antipodal cells.

Fruit and Seed

When furnishing me with a single fruit, Mr. Spawn explained that he had found very few of them. According to Wolf, few fruits are ever formed: he supposes that the shelter under which the plant lives prevents pollination. The fruit (Pl. 11, fig. 14) remains enclosed in the corolla; it is a berry whose one locule is almost completely filled by the enlarged placentae. The elongate cells of the inner epidermis of the ovary wall, which resemble in shape the similarly placed mechanical cells involved in the dehiscence of the capsules of *Allotropa* and *Pterospora,* become enlarged during the development of the fruit; but, having no mechanical functions, they are not thick-walled and not distinguished by staining reactions. The epidermal cells of the placentae fill much space by becoming elongate at right angles to the surface which bears them. My specimen shows very few seeds; most of the ovules have failed to develop.

Plate 9. *Monotropsis odorata.* Fig. 1. Whole plant × 1.6. Fig. 2. Longitudinal section of root tip × 320. Figs. 3, 4, 5, 6. Cross sections of roots × 40: fig. 3, a small root with diarch xylem; fig. 4, a larger root with pentarch xylem; fig. 5, a root with triarch xylem showing attachment of a secondary root; fig. 6, another section of the same root showing an adventitious bud. Fig. 7. Model of the vascular system through six internodes of stem × 8. Fig. 8. Diagram of the vascular system of the stem through eighteen internodes: the transverse dotted lines represent nodes; the diagonal lines represent the parastichies of the 2/5 system.

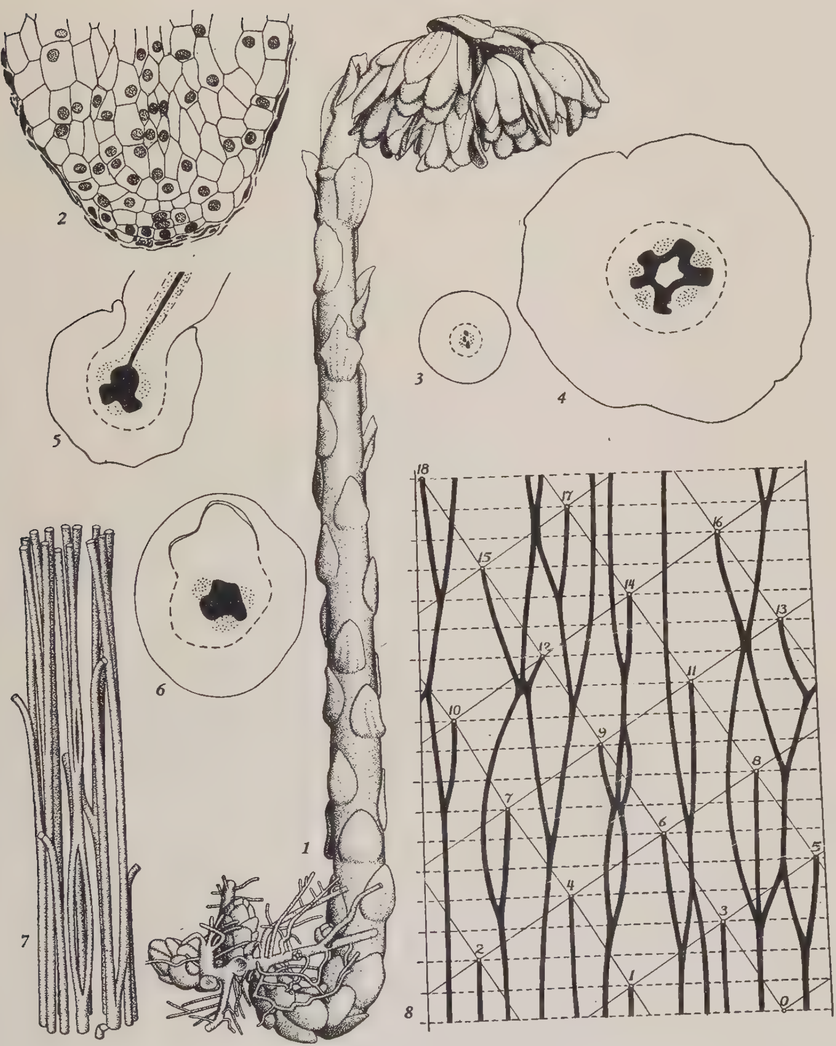

PLATE 9. MONOTROPSIS ODORATA.

The seed (Pl. 11, fig. 29) is minute, ovoid, without appendages. The cells of the outer layer of the integument have developed very thick cell walls on their inner and lateral surfaces, while their outer cell walls tend to collapse. The cells of the inner layer of the integument have disappeared except at the ends of the seed. The endosperm is of but few cells and appears to be without haustoria. The embryo is globular; the one most clearly seen appears to consist of just one radially symmetrical tetrad of cells.

Relationships

Among the genera of Monotropoideae as known to me, the one which is closest to *Monotropsis* is *Hypopitys*. Some Monotropoideae have in the stem a vascular cylinder interrupted only by leaf gaps; these two have a ring of vascular bundles. In the anthers of both, the connective breaks down; in *Hypopitys,* the anther splits from top to bottom (from proximal to distal) in a frontal plane, and becomes explanate. In both genera, the lobes of the nectary are arranged in pairs opposite the saccate bases of the petals. Other genera to be associated with these are the following. (1) *Monotropa* has traditionally included *Hypopitys.* It has separate vascular bundles. The petals are saccate. Pairing of the lobes of the nectary is inconspicuous, but seems to exist. The anthers differ in detail from those of *Monotropsis* but agree in essentials. (2) *Pityopus* differs in having in the stem a vascular cylinder interrupted only by leaf gaps, but agrees in having saccate petals, paired nectaries, and anthers like those of *Hypopitys.* (3) *Monotropastrum,* as represented by a specimen of *M. ampullaceum* from Formosa in the Herbarium of the University of California, shows saccate petals and lobes of the nectary not merely approximate in pairs but connate, forming forked structures embracing the bases of the petalad stamens. The idea that the pairing of the lobes of the nectary is worth noticing comes from the paper of Oliver (21). In the genera just listed, I believe that this character is the mark of a derived natural group.

I must withdraw the opinion that *Newberrya* is closer to *Hypopitys* than to *Pleuricospora. Newberrya* and *Pleuricospora* differ in structure of corolla, in number of placentae, and in pubescence. They agree in having in the stem a vascular cylinder (it is without a sheath of fibers) rather than separate bundles, and in having erect anthers opening through slits. Such anthers are, of course, the ordinary anthers of flowering plants; but here among the Ericales they appear to mark a derived natural group.

Plate 10. *Monotropsis odorata.* Fig. 9. Cross section of vascular bundle ×320. Fig. 10. Longitudinal section of phloem ×560. Fig. 11. Flower ×4. Fig. 12. Flower with perianth removed ×4. Fig. 13. Corolla ×4. Fig. 14. Fruit ×4. Fig. 15. Model of the vascular system in the receptacle of the flower ×40: *Ca,* sepal bundle; *Col,* petal lateral; *Cod,* petal dorsal; *St,* stamen bundle; *Cd,* carpel dorsal; *Pl,* placental bundle.

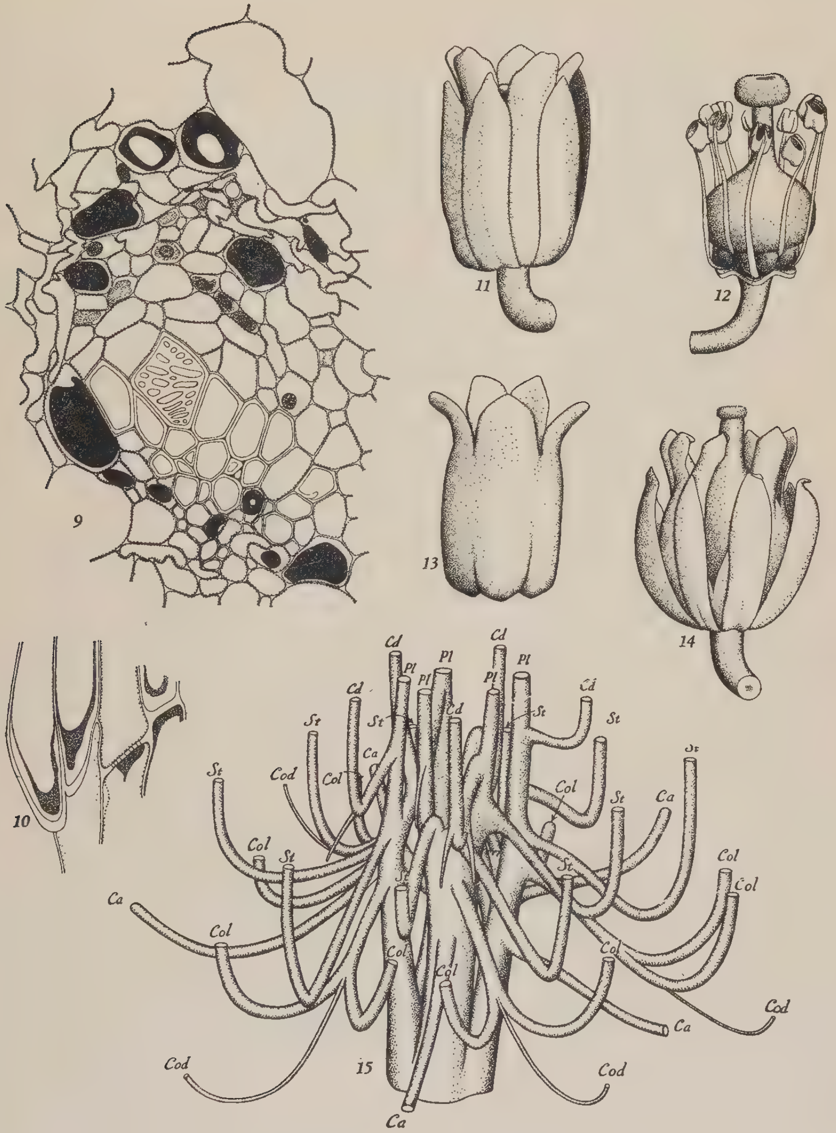

Plate 10. Monotropsis odorata.

Of *Cheilotheca khasiana* I know little more than the name. It has traditionally been associated with the genera now under discussion. *Wirtgenia* (*Cheilotheca malayana* Scortechini *ex* Hooker f.) has been collected only once, many years ago. The original figure (15) seems to show the evenly placed lobes of the nectary and the erect anthers of the present group; but the alternately long and short stamens remind one of *Monotropa*, next to which Andres has placed it. If we can believe that Hooker misconceived the anthers, this is surely its true position.

The recognition of the groups typified respectively by *Hypopitys* and by *Pleuricospora* leaves us still to place *Sarcodes*, *Pterospora*, and *Allotropa*. Each of these genera exhibits characters unique in Monotropoideae: *Pterospora*, the tailed anthers and seeds with flat wings; *Sarcodes*, the peculiar dehiscence of the fruit; *Allotropa*, asepaly, and anthers which turn upside down during development. The three have in common a stout and erect habit, a vascular cylinder in the stem, surrounded by a sheath of fibers, an ovary with axile placentation in the lower half, and evenly distributed lobes of the nectary. I believe that these characters, as well as the sympetaly seen in *Sarcodes* and *Pterospora*, are the primitive characters of the Monotropoideae. The inversion of anthers during development is shared by *Allotropa* with a strangely scattered list of plants, *Saurauia*, *Clethra*, *Pyrola*, and *Chimaphila*. Formerly I took this also to be a primitive character, but I now suppose that it has appeared independently, at least in the present case: that the original monotropoid plant had anthers pointing inward or downward and opening through pores, as in *Sarcodes*, and bearing tails, as in *Pterospora*. It appears to me that the three genera now under discussion may be recognized as constituting the primitive tribe of Monotropoideae. Their divergences from one another suggest that this is an ancient group. Its geographic limitation to North America, and for the most part to the west coast, may be explained by the assumption that it is of such an age that its distribution is no longer indicative of its place of origin, but has been determined by subsequent history.

It will be seen that I am now content to treat the Monotropoideae as a natural group. My previous uncertainty on this point arose from inability to recognize subordinate natural groups. The difficulty seems to have disappeared upon the assumption that the position of the anthers and the arrangement

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PLATE 11. *Monotropsis odorata.* Figs. 16, 17, 18, 19, 20. Cross sections of an open anther × 20. Fig. 21. Diagram of a longitudinal section of an open anther × 20, constructed from figs. 16–20, the planes of which are represented by the transverse lines *a* to *e* respectively. Fig. 22. Pollen grain × 720. Figs. 23, 24, 25. Cross sections of a pistil × 8. Fig. 26. Diagram of a longitudinal section of an ovary × 8, constructed from figs. 23–25, the planes of which are represented by the transverse lines *a* to *c* respectively: *plac*, placenta; *Cd*, carpel dorsal bundle; *Pl*, placental bundle. Fig. 27. Radial section through the stigmatic surface × 320. Fig. 28. Longitudinal section of an ovule × 320. Fig. 29. Longitudinal section of the micropylar end of a seed × 320.

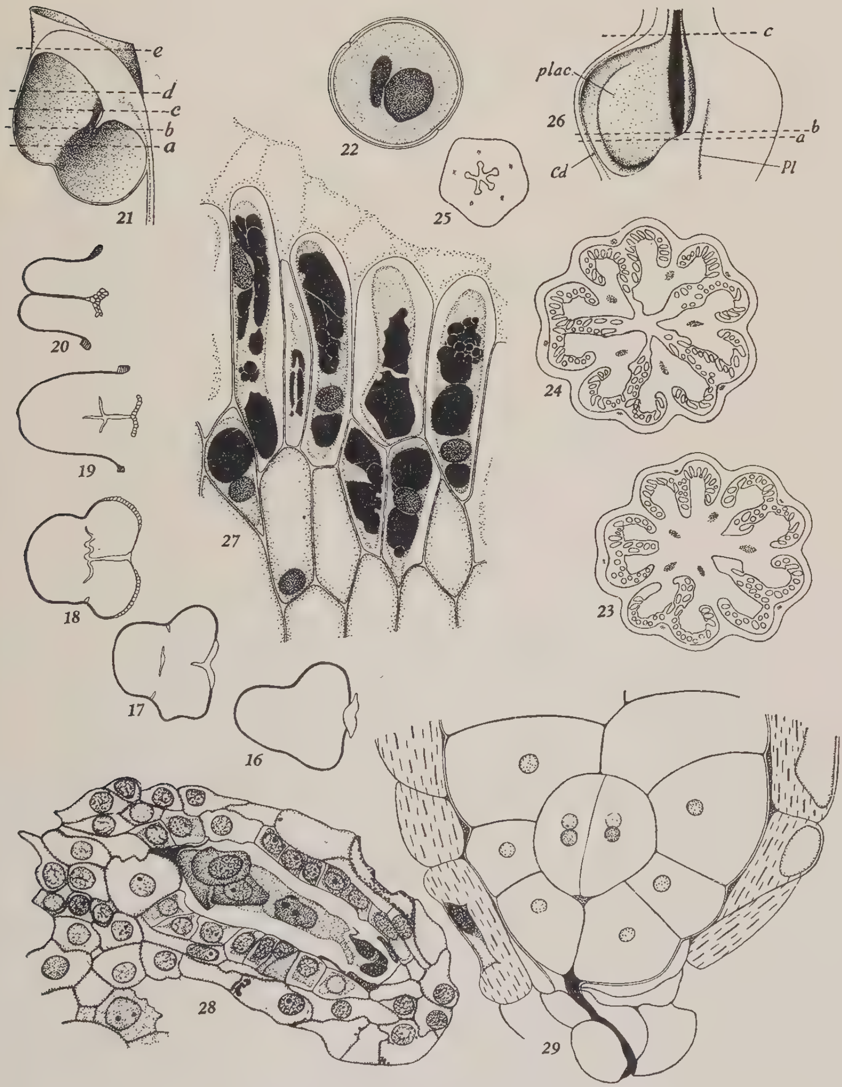

Plate 11. Monotropsis odorata.

of the lobes of the nectary are characters of primary importance. Completely parietal placentation, on the other hand, and likewise choripetaly, seem to have appeared repeatedly. As to the ancestry of the group as a whole, I can support no opinion by much evidence. The problem will no doubt eventually be solved by studies of comparative anatomy; and, considering the tailed anthers of *Pterospora,* I would study first of all the Arbutoideae. The Pyroloideae may well be of the same ultimate origin as the Monotropoideae; but it is not clear to me that these two groups are closer to each other than to any other group of Ericales. We may avoid taking a definite position in a matter which is as yet uncertain by not recognizing the family Pyrolaceae; by including Pyroloideae and Monotropoideae in Ericaceae as separate subfamilies, as in Jepson's treatment (16). The views just stated may be expressed as follows:

ERICACEAE, SUBFAMILY MONOTROPOIDEAE

A. Tip of the filament at maturity bent inward so that the distal end of the anther is directed toward the interior or the base of the flower.
  1. Stem including a vascular cylinder with a sheath of fibers; lobes of the nectary evenly spaced; ovary with axile placentation in the proximal part; fruit a capsule:
     Tribe PTEROSPOREAE: *Pterospora, Sarcodes, Allotropa.*
  2. Stem including a vascular cylinder or vascular bundles without a sheath of fibers; lobes of the nectary approximate in pairs opposite the saccate bases of the petals; ovary and fruit as above or else unilocular to the base and becoming a berry; anthers at maturity containing a single chamber, sometimes splitting in a frontal plane and becoming explanate:
     Tribe MONOTROPEAE: *Monotropsis, Hypopitys, Pityopus, Monotropa, Wirtgenia?, Monotropastrum.*

B. Tip of the filament erect, the distal end of the anther directed toward the summit of the flower; stem including a vascular cylinder without a sheath of fibers; lobes of the nectary evenly spaced; anthers opening by longitudinal slits; fruit baccate:
   Tribe PLEURICOSPOREAE: *Newberrya, Pleuricospora, Cheilotheca?*

Sacramento Junior College,
Sacramento, California, March, 1939.

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OBSERVATIONS ON THE ELONGATION OF THE STIPE OF MONTAGNITES

Clayton O. Smith

Montagnites Candollei var. *texensis* Berk. & Curt. occurs under natural conditions in uncultivated and nonirrigated lands of the University of California Citrus Experiment Station, Riverside, California. The plants are gregarious and appear in March and April after the winter rains if environmental conditions have been favorable. Mature plants are most often found; younger stages are less often seen, probably because of the rapid elongation of the stipe which, under favorable conditions, can carry the spore-bearing part in a few hours from beneath the soil to several inches above it.

Stipe elongation was observed in a young plant in the button stage (text fig. 1, a). At this stage the stipe was the same length

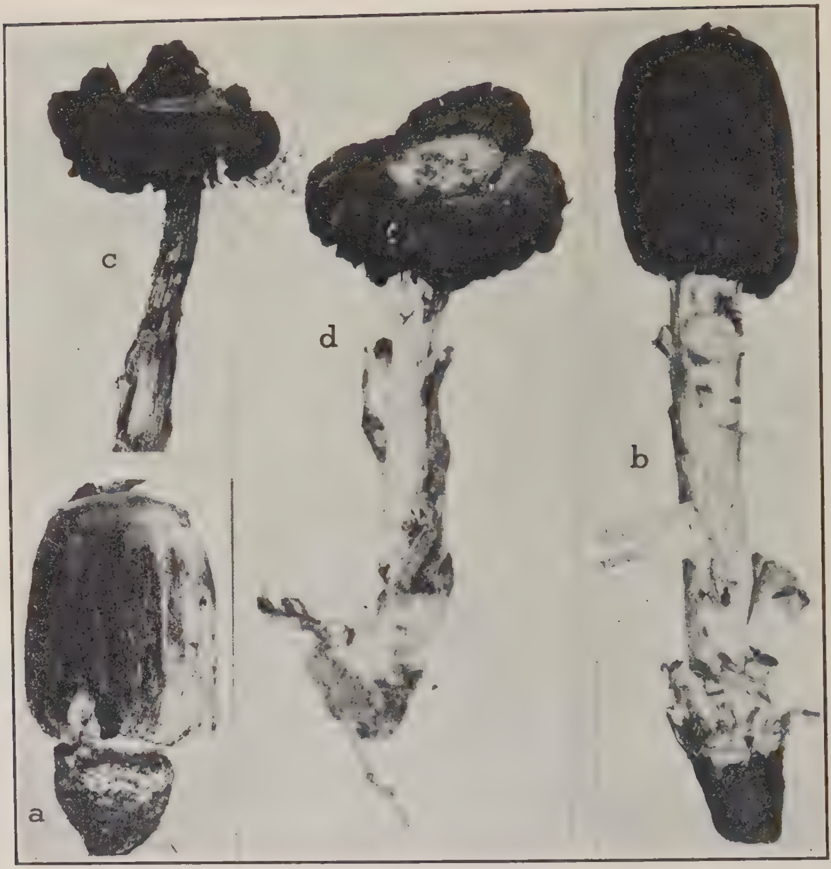

Fig. 1. *Montagnites Candollei* var. *texensis* Berk. & Curt.: *a*, button stage showing the enlarged base from which the volva extended (volva remains on cap); *b*, same plant as shown in *a* after several hours in a moist chamber; *c* and *d*, expanded mature plants showing a mass of spores between the caps.

as the unexpanded pileus, about two inches. After being in a moist chamber for a few hours it had elongated to four and one-half inches, or more than twice its former length; the cap was still unexpanded (text fig. 1, b). The surface of the stipe became ruptured during the process of elongation, thus giving it a scaly appearance.

Citrus Experiment Station,
University of California, Riverside,
September 20, 1938.

TRANSPARENT MOUNTS FOR FIELD HERBARIA

FERDINAND W. HAASIS

In describing a method of mounting plant specimens with transparent cellophane tape on index cards, Pierce[1] suggested that under some conditions transparent mount sheets might prove superior to the cards. The following is a summary of personal experience with a modification of Pierce's method. Developed primarily to make diseased tree leaves available for reference and demonstration in field work, the procedure has also been tried out with a number of other kinds of specimens.

A transparent mount is ideal for samples of virosis mottlings, details of which can be seen better by transmitted than by reflected light; also when it is desirable that both sides of a specimen should be visible. For thick material the transparent sheet provides a smooth surface through which the specimen can be seen to excellent advantage. In my work I have used two kinds of transparent mounts. In one the specimen is placed between two layers of "Scotch cellulose tape" in windows cut in small cards. The other, which is less laborious and which results in a better specimen, involves the use of a transparent mounting sheet. While there are doubtless a number of substances which would be suitable for this, I have experimented only with "Plastacele," a cellulose acetate product, using the 0.010-inch thickness, which is about the weight of postal card stock.

The specimens are mounted soon after collection, sometimes at once, and usually within eighteen hours. If mounting is delayed for longer periods there is risk that they will become shrivelled, brittle, or discolored. When held for a few hours, they are placed in newspaper folders made up into small bundles with stiffening cards (about four by six inches) and held together with stout rubber bands. The leaves in the folders should be separated to avoid discoloration and blotters should be placed between the specimen folders.

When practicable, collection of especially turgid samples should be avoided; any superficial water should be gently blotted off before mounting. With delicate tissues, handling should be reduced to a minimum to prevent bruising. Forceps can often be used to advantage. For displaying flower petals (pear or cherry, for instance), the thickness of the preparation may be reduced by cutting off the ovary before mounting and using a longitudinal section through a nearly open bud to show ovary, pistils, stamens, ovules, and pollen.

In using cards with windows, the first layer of tape is applied with the card face down against a smooth surface such as glass or painted wood. On plastacele, the tape is ordinarily put on what is to be the back of the mount so that the more significant facies of the specimen will be against a smooth surface. It is important to seal the mount tightly while still avoiding crushing the tissues.

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[1] Pierce, W. Dwight. Retention of plant colors, Science 84: 253–254. 1936.

The mounted specimens are dried between blotters for about a week, the packs of mounts and blotters being held together with rubber bands with no additional pressure. Except in very dry weather it is best to change blotters every day or two.

The specimens are kept on four by six inch sheets in fascicles not more than an inch in thickness with pressboard covers, fastened together with two looseleaf rings and tied with tape tabs. Descriptive notations are made on cards hinged to the mount sheets.

The following observations, made in May, 1939, will give an indication of the permanence reasonably to be expected of these preparations, a question of paramount interest to the field worker. The 1937 specimens were mounted between two layers of tape, while in 1938 and 1939 plastacele mount sheets were used.

Specimens of mosaic-mottled leaves include almond, apricot, myrobalan plum, peach, plum, and prune, varying in age from ten to nineteen months. Although the mosaic patterns are still plainly visible on the 1937 leaves, some of the specimens have suffered a slight color change, the green having taken on a yellowish-brown cast, possibly the result of accidental exposure to strong sunlight. The color change in the 1938 specimens is negligible.

Among other satisfactory preparations are: western celery mosaic (2 months); powdery mildew on peach (10 months); sugar beet curly top, sugar beet mosaic, fig mosaic and tulip petal breaking (12 months); downy mildew on alfalfa (13 months); tomato with mild tobacco mosaic (14 months); and powdery mildew on barley (15 months). A set of young seedlings of lettuce, onion, tomato, and beet, mounted within an hour of gathering, are still in good condition after fifteen months, though the green is becoming somewhat pale, and the characteristic red markings of the beet are gone. Lichens (*Cetraria, Cladonia, Parmelia, Usnea*), rusts, and alfalfa leaf spot show no significant change a year or more after mounting.

In spite of the seemingly casual method of drying these specimens, there has been practically no trouble with molding, presumably because of the exclusion of air by the rubber cement of the tape. The collections have furthermore been wholly free of herbarium insects, though as field specimens they have not, needless to say, been stored in insect-proof containers nor treated with any repellent aside from the tape itself.

Carmel, California,
May 2, 1939.

NOTES ON LACTUCA IN WESTERN NORTH AMERICA

G. Ledyard Stebbins, Jr.

The genus *Lactuca* is represented in western North America by only two or three native species, but several eastern American and Old World species have become established as weeds. Examination of specimens in the University of California Herbarium and the writer's own field observations show that three of these, *Lactuca virosa* L., *L. saligna* L., and *L. muralis* (L.) Fresen., are not listed in the California floras, while a range extension can be reported on a fourth, *L. spicata* (Lam.) Hitchc. In addition, the widespread and unquestionably native western form which has long been recognized as a distinct species, *L. pulchella* (Pursh) DC., is apparently only a geographic variety, or subspecies of the Old World *L. tatarica* (L.) C. A. Mey. The present paper is a discussion of these findings.

Lactuca tatarica (L.) C. A. Mey. subsp. **pulchella** (Pursh) comb. nov. *Sonchus pulchellus* Pursh, Fl. Am. Sept. 2: 502. 1814. *Lactuca pulchella* DC., Prodr. 7: 134. 1843. *Mulgedium pulchellum* Nutt. Trans. Am. Phil. Soc. n.s. 7: 441. 1840; Torr. *et* Gray, Fl. N. Amer. 2: 497. 1843.

The fact that the American form generally recognized as *Lactuca pulchella* is not specifically different from *L. tatarica* was first recognized by Lindberg (4). He found the two "species" recorded in Lindman's Swedish flora as adventive plants in Sweden, and placed in different genera, that is *Mulgedium tataricum* and *Lactuca pulchella.* The chief differences suggested by Lindman were in the achenes and the pappus. Lindberg investigated these and other characteristics in a series of twenty-four specimens of the Old World *L. tatarica* from various localities and six of *L. pulchella* from North America, and concluded that the two series were identical.

The writer has compared the fifty-four specimens of *Lactuca pulchella* from the University of California Herbarium with a series of fifteen specimens of *L. tatarica,* most of which were received on loan from the United States National Herbarium through the kindness of its curator. The majority of these are from northwestern India, but three are from Mongolia, one is from northern China, and one (University of California Herbarium) from southern Europe. This comparison confirms in general the opinion of Lindberg. In their corollas, anthers, stigmas, and achenes the two forms are identical. The variation in achene shape of the Old World form as illustrated by Lindberg (4, p. 657) is exactly matched in the series that the writer has seen from America. There are, however, certain differences in habit, as follows. The stems of *L. tatarica* subsp. *pulchella* average slightly taller than those of the Old World *L. tatarica,* and are less branched, while the cauline leaves, as noted by Lindberg, are more numerous (10 to 30 below the lowest branch of the inflorescence in subsp. *pulchella,* 3 to 12 in the Old World form). The leaves are similar in size, shape, and texture in the two forms, and in both may be either entire or pinnatifid. The leaf margins in subsp. *pulchella* are quite entire or remotely and minutely denticulate, while in all the Old World specimens seen by the writer they are conspicuously spinulose-denticulate. Lindberg, however, cites a collection by Sintenis from Aschabad with entire leaves. The involucral bracts are usually more closely imbricated in subsp. *pulchella* than in the typical form, while their tips tend to be narrower and more attenuate. One specimen from California, however (Warner Mts., Modoc County, *Frost 112*), exactly matches the Indian, Mongolian, and Chinese specimens in this respect.

Although these differences give the two series a sufficiently different aspect so that they can easily be distinguished, there is no characteristic in which overlapping has not been found. Both subspecies occupy somewhat similar habitats; moist, often somewhat saline meadows or sandy stream margins in semiarid, cool temperate steppe country. The typical form, however, apparently grows in somewhat drier situations than does subsp. *pulchella.* In their somatic chromosomes the two are indistinguishable. The somatic number $2n = 18$ has already been reported for *Lactuca tatarica* (2), while the same number and a similar karyotype have been seen in root tips of a culture of subsp. *pulchella* grown from seed kindly sent to the writer by Dr. H. Hapeman, Minden, Nebraska. There has been no opportunity to test whether the two forms belong to the same ecospecies as defined by Turesson (cf. Clausen, Keck, and Hiesey, 3). Both set seed very sparingly in Berkeley, so that data on the fertility of hybrids grown in this climate would be meaningless. Judging from the experience in this and other laboratories on hybrids in *Lactuca* and other genera of Cichorieae, the two forms would probably be perfectly interfertile when crossed under suitable growing conditions.

This close similarity between two plants, one characteristic of the steppes of central Asia and one of North America has already been noted by the writer (1, p. 32) and is paralleled by several other species groups. *Lactuca tatarica* has the smallest gap in its distribution of any of these species, since it extends northwestward in the New World to Alaska, and eastward in the Old World to Manchuria. All of its relatives are central Asiatic, with their center of distribution in the Altai-Thian Shan mountain region. The ancestors of subsp. *pulchella,* therefore, probably migrated across the Siberian-Alaskan land bridge during late Pliocene or Pleistocene time.

LACTUCA SPICATA (Lam.) Hitchc. The occurrence of this species in California was predicted as early as 1876 by Gray (Bot. Calif. 1: 442). It is now recorded from the following localities: Olema, Marin County, *T. S. Brandegee*; south of Eureka, Humboldt County, *M. E. Jones 29090;* Trinity River Valley, Humboldt County, alt. 200 m., *Tracy 7746, 14118;* near Myers, Humboldt County, *Tracy 13583.*

It is apparently rare or local in the redwood forest. Mr. Joseph P. Tracy, who discovered all of the exactly known localities for *Lactuca spicata,* has written (in litt.) that it appears as if it were native, but the possibility of its introduction from farther east cannot be excluded, since the species in eastern America readily spreads to forest clearings and other habitats more or less remote from human habitation. There are no discernible differences between the California specimens and those from the east.

LACTUCA MURALIS (L.) Fresen. (*Mycelis muralis* Reichenb.; *Cicerbita muralis* Wallr.)

This European species is apparently introduced on Vancouver Island, British Columbia, as evidenced by the following collection: Sooke Harbor, 1930, *Setchell and Parks.* It is a very distinctive woodland species with thin, often purplish, lyrate or runcinate-pinnatifid and angulate-toothed leaves and ample panicles of small heads. The involucral bracts are biseriate, with the outer series calyculate as in *Prenanthes;* they enclose five yellow florets. The achenes are deep brownish or reddish, conspicuously flattened, and bear a pale, not filiform beak about one-fifth their length.

LACTUCA VIROSA L. This species, which has often been erroneously reported from the United States through misidentification of the quite different *L. Scariola* L. var. *integrata* Gren. *et* Godr., is now well established in the vicinity of Berkeley. It differs from all forms of *L. Scariola* in its biennial habit, more strongly dentate leaves, and in particular by its larger corollas and very different achenes. The latter are, in *L. virosa,* black, rugose but not setose, and conspicuously wing-margined, while in *L. Scariola* they are gray or brownish, narrower, minutely rugulose on the ribs below but setose above, and marginless. The stem leaves of *L. virosa* are usually entire or less markedly pinnatifid than are those of typical *L. Scariola,* but this difference is not pronounced, so that emphasis on it has led to considerable confusion.

Usually *Lactuca virosa* does not become a field or roadside weed as does *L. Scariola,* but prefers half-wild places, often growing in rock crevices. Its large rosettes of obovate, spinulose-toothed leaves are a conspicuous feature of the winter vegetation of the Berkeley Hills. The writer has frequently seen *L. virosa* and *L. Scariola* growing together but has not found any indication of natural hybridization between them. The following specimens in the University of California Herbarium may be cited: Campus, Berkeley, *Mason 3642;* Strawberry Canyon, Berkeley, *Parks 0701.*

Lactuca saligna L. This European weed, although well established for some time in the San Francisco Bay area, has not found its way into the floras. It is distinguished from *L. Scariola* chiefly by its smaller, semi-decumbent habit, narrower leaves, and spike-like inflorescences. It flowers somewhat later than do *L. virosa* and *L. Scariola.* These three European weeds may be identified by the following key:

Plant biennial; achenes black, rugose, conspicuously wing-margined .... *L. virosa*

Plant annual; achenes gray or brownish, minutely rugulose on the ribs below, spiculate or setose toward the apex, not wing-margined.

Leaves oblong or elliptic in outline, their margins conspicuously spinulose-denticulate; panicle open, with widely spreading branches; involucres with 14–20 florets; achenes setose above.

Leaves pinnatifid .... *L. Scariola*

Leaves oblong, entire .... *L. Scariola* var. *integrata*

Leaves linear-lanceolate, or pinnatifid with linear-lanceolate lobes; their margins entire or remotely denticulate; panicle spiciform, with short, ascending branches; involucres with about 8–10 florets; achenes merely spiculate above .... *L. saligna*

Lactuca Scariola L. The typical form of this species, with pinnatifid leaves, is a common weed throughout western North America.

Lactuca Scariola var. integrata Gren. et Godr. Although it is much the most common form in the eastern United States, the variety occurs only occasionally in California. It is usually a smaller plant than the pinnatifid-leaved form, and is apparently adapted to a cooler climate and a shorter growing season.

Division of Genetics
University of California,
Berkeley, April, 1939.

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TWO INTERESTING SPECIES OF DRABA FROM THE CHARLESTON MOUNTAINS OF NEVADA

C. Leo Hitchcock

Among the many interesting discoveries Mr. I. W. Clokey has made in his botanical exploration of the Charleston Mountains are two species in the genus *Draba*. Puzzled as to their identity, and suspecting that they were new to science, Mr. Clokey kindly turned them over to me for study. Since he is endeavoring to clarify and enumerate the known flora of the Charleston Mountains, it seems advisable to discuss these plants at this time.

Draba paucifructus Clokey et C. L. Hitchcock sp. nov.

Planta perennans, 4–12 cm. alta, multicaulis, inferne vestigiis foliorum emortuorum persistentibus; caulibus simplicibus, aphyllis vel 1–2-phyllis, glabris vel inferne pilis stellatis adspersis; foliis basilaribus rosulatim congestis, obovatis ad obovato-oblanceolatis, integris vel denticulatis, 3–15 (25) mm. longis, 1.5–4 (8) mm. latis, pilis ramuloso-stellatis hirtis, ad pilis simplicibus ciliatis; racemis 3–12-floribus; pedicellis 1–5 (7) mm. longis; sepalis 1.5 mm. longis, pilis symplicibus vel stellatis obsitis; petalis albis, spathulatis, *ca.* 2.5 mm. longis; ovariis 20–30-ovulatis; siliculis in pedicellis erecto-patulis 1–5–(7) mm. longis adscendentibus, lineari-lanceolatis vel elliptico-lanceolatis, 5–10 mm. longis, 1.5–2.25 mm. latis, compressis, stylis brevissimis (0.1–0.2 mm.) coronatis.

A low perennial 4–10 (12) cm. tall, with 1 to several crowns, each crown with 1–4 stems; leaves numerous, nearly all in basal rosette, obovate to obovate-oblanceolate, rounded to obtuse, entire or very remotely denticulate, 3–15 (25) mm. long, 1.5–4 (8) mm. broad, rather densely pubescent with 4–7-rayed, nearly sessile stellae, the margins also more or less short ciliate, midribs marcescent; stems glabrous, or slightly stellate near base, usually devoid of leaves, sometimes with 1 leaf at base, less commonly the first flower from a leaf-axil; racemes elongate, mostly at least half the total height of plant, only 3–12-flowered; pedicels glabrous, erect or nearly so, 1–5 (7) mm. long; sepals *ca.* 1.5 mm. long, somewhat pilose to stellate; petals white, nearly spatulate, rounded to retuse, *ca.* 2.5 mm. long; silicles linear-lanceolate to narrowly elliptic-lanceolate, 5–10 mm. long, 1.5–2.25 mm. broad, flattened; style barely noticeable (0.1–0.2 mm. long); seeds 20–30.

Type. Peak Trail, Charleston Mountains (Spring Mountain Range), Nevada, at 3180 meters, August 3, 1938, *Clokey 7953*, in the Clokey Herbarium; isotype in the University of Washington Herbarium.

Other material (all from the Charleston Mountains, Nevada). Rainbow Falls, August 3, 1937, *Clokey 7526;* Kyle Canyon, July

Table 1.—Comparison of *Draba paucifructus, D. nivalis, D. crassifolia* and *D. stenoloba*

D. paucifructus	*D. nivalis*	*D. crassifolia*	*D. stenoloba*
perennial, crowns usually more than one	perennial, crowns usually more than one	biennial or shortlived perennial	biennial or short-lived perennial
plants usually less than 10 cm. tall	plants usually less than 10 cm. tall	plants usually less than 10 cm. tall	plants usually over 10 cm. tall
leaves mostly basal (sometimes one or two cauline)	leaves mostly basal (sometimes one or two cauline)	scarcely ever with cauline leaves	always with one or (more frequently) two to several cauline leaves
pubescence of leaves abundant, several-rayed, but not stellate-pannose, not cinereous	pubescence of leaves dense, finely stellate-pannose, usually cinereous	leaves glabrous or ciliate	leaves ciliate and often with 4–7-rayed hairs
stems glabrous or but sparsely stellate at base	stems usually stellate	stems glabrous	stems strigose usually
silicles 3–12, 5–10 mm. long, much like those of *D. crassifolia*	silicles 3–15, 7–20 mm. long	silicles 5–20, 5–10 mm. long	silicles 10–30, 8–15 mm. long
styles 0.1–0.2 mm. long	styles 0.2–0.5 mm. long	styles lacking	styles lacking

22, 1930, *Goodman & Hitchcock 1682* (Dudley Herb., Stanford and Mo. Bot. Gard.); eastern slope at 10,000 feet, June 26, 1926, *E. C. Jaeger* (Pomona); Big Falls, July 14, 1937, *Clokey 7425;* Peak Trail, August 8, 1935, *Clokey 5483,* July 22, 1937, *Clokey 7795;* Charleston Peak, July 16, 1936, *Clokey 7112,* July 22, 1937, *Clokey 7527,* August 3, 1938, *Clokey 7952.* For nearly all the Clokey collections a large number of duplicates was prepared and these will eventually be distributed rather widely.

The relationship of this species is exceedingly perplexing. Mr. Clokey, who had an excellent opportunity of observing it in the field, was convinced that it was undescribed and had prepared a specific description before he sent me the material. I, too, was convinced of its novelty but thought it might feasibly be accorded varietal rank under *Draba nivalis* Lilj. (*D. lonchocarpa* Rydb.). However, it cannot with certainty be considered more closely related to that species than to *D. crassifolia* Grah. or even to *D. stenoloba* Ledeb. I agree, therefore, with Mr. Clokey, that it must be considered to be of specific rank and regard it as having evolved in this isolated southern mountain range. Perhaps the most striking thing about the species is its remarkable constancy. Mr. Clokey has collected many individuals and they are all as nearly alike as plants can reasonably be expected to be. Incidentally, the same can be said for the other species peculiar to this region, namely, *D. Jaegeri* Munz & Johnston, although it has been collected so much less frequently that the assertion is made with less assurance.

The reason for according *Draba paucifructus* specific rank can best be seen by comparing it (Table 1) with the three species with which it is most likely to be confused.

From the above comparison it may be seen that *Draba paucifructus* is perhaps most closely related to *D. nivalis* and it seems not unlikely that it is really a stranded relative of that species, differing chiefly in the shorter fruits and in the much less abundant, coarser pubescence on the leaves.

The other species, represented by three collections from Rainbow Falls, Charleston Mountains, *Clokey 7111, 7951,* and *8202,* is *Draba brachystylis* Rydberg (Bull. Torr. Bot. Club 29: 240. 1902). Since *D. brachystylis* has been known hitherto only from the Wasatch Mountains of Utah (collections from American Fork Canyon, Alta, and Thistle, by M. E. Jones, and from Big Cottonwood Canyon, *Rydberg & Carlton 6417* and *Garrett 1336*) its discovery in the Charleston Mountains is indeed surprising; however, there can be little doubt of its identity since the collections made by Clokey are practically identical with that of Rydberg and Carlton.

University of Washington,
Seattle, December 8, 1938.

NOTES ON CERTAIN CRUCIFERAE OF MEXICO AND SOUTHWESTERN UNITED STATES

REED C. ROLLINS[1]

A series of specimens from Mexico recently referred to me for determination by Dr. I. M. Johnston, served to call my attention to the need for critical study in two rather poorly known genera of the Cruciferae. After a superficial examination, it soon became evident that a complete study of both genera would be necessary before they could be clearly understood and the plants placed with some certainty. The genera involved are *Nerisyrenia,* more familiarly known as *Greggia* of Gray, and *Synthlipsis.* Both are small genera of the western hemisphere and have a rather limited distribution in southwestern United States and northeastern Mexico. Much of the previous work on these genera has been done at the Gray Herbarium, hence the types and annotated or critical specimens have been readily available for study. Specimens cited throughout this paper are deposited in the Gray Herbarium unless otherwise specifically designated.

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[1] Society of Fellows of Harvard University

Nerisyrenia and *Synthlipsis* are closely related and it was at first thought that together they might form a sufficiently homogeneous group to be treated as a single genus. However, the following tabulation of their distinctive characteristics effectively demonstrates the generic nature of each.

NERISYRENIA: cotyledons incumbent; seeds numerous (more than 40 in each silique), less than 1 mm. broad; siliques with rounded margins; capitate stigma cylindrical; petals dilated and sparsely denticulate at base.

SYNTHLIPSIS: cotyledons accumbent; seeds less than 25 in each silique, *ca.* 2 mm. broad; siliques carinate; capitate stigma discoid; petals entire and not dilated at base.

Nerisyrenia was first recognized as a distinct genus by Gray, who named it *Greggia* in honor of Dr. Josiah Gregg. At the time he was fully aware of, and even mentioned, the earlier *Greggia* of Engelmann pointing out that Engelmann's plant had proved to be a *Cowania.* Thus Gray fell into a situation which, after the acceptance of our present "later homonyn rule," made rejection of the name of his proposal mandatory upon later workers. The genus has three species, one of which has been examined for the purpose of determining the number of chromosomes present. A collection of *Nerisyrenia camporum* was made in Big Bend State Park, Brewster County, Texas, on September 6, 1938, *Rollins & Chambers 2767.* An examination of developing pollen after acetocarmen staining showed the number to be N = 7.

NERISYRENIA

Nerisyrenia Greene, Pittonia 4: 225. 1900.

Greggia Gray, Smiths. Contrib. (Pl. Wright.) 3: 7. 1855; not *Greggia* Gaertn., Fruct. 1: 168. 1788; not *Greggia* Engelmann in Wisliz., Mem. Tour No. Mex. 114. 1848.

Parrasia Greene, Erythea 3: 75. 1895, based on *Greggia* Gray; not *Parrasia* Rafin. Fl. Tellur. 3: 78. 1837.

KEY TO THE SPECIES

Siliques entire at apex, densely pubescent but never white, 1.5–3 mm. wide; plants densely pubescent but not hoary.
  Leaves spatulate to oblanceolate, dentate to repand, infrequently entire, 4–15 mm. wide, siliques slightly compressed contrary to partition .... 1. *N. camporum*
  Leaves narrowly linear, entire, less than 3 mm. wide, siliques terete .... 2. *N. linearifolia*
Siliques notched at apex, incanous, 3–5 mm. wide; plants hoary throughout .... 3. *N. incana*

1. Nerisyrenia camporum (Gray) Greene, Pittonia 4: 225. 1900.

Greggia camporum Gray, Smiths. Contrib. (Pl. Wright.) 3: 7. 1855.

Greggia camporum Gray var. *angustifolia* Coulter, Contrib. U. S. Nat. Herb. 1: 31. 1890.

Parrasia camporum (Gray) Greene, Erythea 3: 75. 1895, based on *Greggia camporum* Gray.

Representative specimens. Texas. W. Texas—El Paso, Oct. 1849, *C. Wright 11* (Gray, type). Brewster County: Big Bend State Park, Sept. 1938, *Rollins & Chambers 2767;* 3 miles below Study Butte, June 1931, *Moore & Steyermark 3247;* near Persimmon Gap, April 1931, *McKelvey 1972.* Maverick County: hills near Eagle Pass, April 1900, *Pringle 9038.* Presidio County: near Shafter, April 1931, *McKelvey 2045.* LaSalle County: Cotulla, March 1917, *E. J. Palmer 11304.* Val Verde County: Del Rio, Feb. 1937, *Cory 21025.* El Paso County: El Paso, May 1881, *Lemmon 113.* Reeves County: July 1928, *Cory 1626.* Ward County: Barstow, April 1902, *Tracy & Earle 25.* New Mexico. Without locality, 1852, *C. Wright 1316;* plains south of Lunas Well, July 1897, *Wooton.* Lincoln County: White Mts., July 1897, *Wooton 176.* Otero County: Alamogordo, April 1902, *Rehn & Viereck.* Grant County: upper corner monument, May 1892, *Mearns 8.* Mexico. Nuevo Leon: Monterey, March 1880, *E. Palmer 47.* Coahuila: Saltillo, July 1880, *E. Palmer 2145;* 24 miles west of Saltillo, Sept. 1938, *Johnston 7668;* valley west from Melville Station, Sept. 1938, *Johnston 7329;* 70 miles southwest of Parras, May 1880, *E. Palmer 27;* 55 miles west of Saltillo, Sept. 1938, *Johnston 7696;* 3 miles south of Peña, Sept. 1938, *Johnston 7727;* 9 miles east of Cuatro Cienegas, Aug. 1938, *Johnston 7104;* 1 mile south of Hermanas, Aug. 1938, *Johnston 7067;* 16 miles south of Laguna del Rey, Sept. 1938, *Johnston 7814.* Durango: 2 miles west of Bermejillo, Sept. 1938, *Johnston 7753;* 14 miles west of Mapimi, Sept. 1938, *Johnston 7758.* Chihuahua: 5 miles south of Jimenez, Sept. 1938, *Johnston 7845.*

Nerisyrenia camporum varies widely in width and degree of entirety of its leaves. A broadly spatulate-repand leaf appears to be the most prevalent type, but entire rather narrow leaves are not uncommon. Plants with the latter type were designated variety *angustifolia* by Coulter, but this form shows no geographic continuity and cannot, in my opinion, be justifiably maintained as a taxonomic entity. Plants with relatively narrow, entire or nearly entire leaves have been collected from such widely separated localities as Barstow, El Paso and Rio Grande in Texas, Alamogordo in New Mexico and Laguna del Rey in Coahuila, Mexico. These localities circumscribe much of the area occupied by the typical form of the species. The narrow-leaved forms of *N. camporum* are not to be confused with *N. linearifolia* which is an amply distinct natural species. *Nerisyrenia linearifolia* in addition to the distinctive very narrow entire foliage has numerous slender stems which seldom reach more than a decimeter in length, slender cylindrical siliques and a more scanty pubescence throughout the entire plant than any forms of *N. camporum.*

2. NERISYRENIA LINEARIFOLIA (Watson) Greene, Pittonia 4: 225. 1900.

Greggia linearifolia Watson, Proc. Am. Acad. 18: 191. 1883.

Greggia camporum Gray var. *linearifolia,* M. E. Jones, Proc. Calif. Acad. 5: 625. 1895.

Parrasia linearifolia Greene, Erythea 3: 75. 1895, based on *G. linearifolia* Watson.

Dr. Johnston reports that all his collections of this species from Mexico were obtained on gypsaceous soil and that the plant species associated with it were the same in a remarkable number of instances.

Representative specimens. TEXAS. Bluffs of Delaware Creek, 1882, *V. Havard* (Gray, type); Rio Grande, 1848, *Wright.* NEW MEXICO. White Sands, Doña Ana County, July 1897, *Wooton 158;* Fort Sumner-Roswell, May 1931, *A. Nelson 11311.* MEXICO. COAHUILA: Parras, April 1880, *E. Palmer 46;* 6 miles north of La Ventura, Sept. 1938, *Johnston 7638.* SAN LUIS POTOSI: 2 miles south of Cedral, Sept. 1938, *Johnston 7583;* 6 miles north of San Vicente, Sept. 1938, *Johnston 7616;* 38 miles south of Matehuala, Sept. 1938, *Johnston 7509.* ZACATECAS: Sierra Hermosa, Sept. 1938, *Johnston 7402.*

3. **Nerisyrenia incana** sp. nov.

Herba perennis suffruticosa incana; caulibus a basi ramosis 1–2 dm. longis; foliis spathulatis vel obovatis integris 1–4 cm. longis, 5–15 mm. latis; inflorescentiis racemosis laxis; sepalis oblongis cano-pubescentibus 4–6 mm. longis, ca. 2 mm. latis; petalis albis obovatis e basi dilatatis 9–11 mm. longis, 3–5 mm. latis; pedicellis divaricatis vel reflexis 4–7 mm. longis; siliquis oblongis retusis cano-pubescentibus 7–10 mm. longis, 3–5 mm. latis; stylo 2–3 mm. longo; seminibus alatis ca. 1 mm. latis.

Suffruticose perennial, incanous throughout with a dense covering of intricately branched trichomes; stems several to numerous, branching from base, 1–2 dm. high, simple or branched above, older stems with slightly furrowed grey bark, younger stems white, the furrowing imperceptible; strictly basal leaves absent; cauline spatulate to obovate, obtuse, petiolate, entire or very rarely obscurely dentate, 1–4 cm. long, 5–15 mm. broad; inflorescence racemose, rather lax; sepals densely pubescent, oblong, somewhat involute, 4–6 mm. long, ca. 2 mm. wide; petals white, obovate, markedly dilated at base with a few small teeth on the margin, 9–11 mm. long, 3–5 mm. broad; pedicels rather stout, white, divaricate to somewhat reflexed, 4–7 mm. long; siliques oblong, apex notched, somewhat compressed contrary to septum, densely whitish pubescent, 7–10 mm. long, 3–5 mm. wide; style 2–3 mm. long; seeds brown, wingless, less than 1 mm. broad, more than 50 in each silique.

MEXICO. Infrequent in alkaline flats, associated with *Dondia,* 4 miles west of Cuatro Cienegas, Coahuila, Aug. 24–26, 1938, *I. M. Johnston 7130* (Gray, type).

Nerisyrenia incana is most nearly related to *N. camporum* from which it differs in having a dense covering of white trichomes, entire smaller spatulate leaves and short broad siliques which are markedly notched at the apex. The two species are easily recognized as distinct on morphological grounds alone, but their habitat is also vastly different. *Nerisyrenia incana* grows in soil which is strongly alkaline. In this respect it is certainly unique in the genus and possibly in the family as well. *Nerisyrenia camporum,* on the other hand, is less selective and occurs in a variety of soil-types. *Nerisyrenia incana* is known only from the type collection, but this is adequate in every way and includes both flowers and fruits.

SYNTHLIPSIS

Synthlipsis Gray, Mem. Am. Acad. ser. 2, 4: 116. 1849.

1a. SYNTHLIPSIS GREGGII Gray var. **typica** nom. nov.

Representative specimens. TEXAS. Maverick County: Eagle Pass, April 1931, *M. E. Jones 28078;* Rio Grande Valley near Eagle Pass, April 1900, *Pringle 8329.* Webb County: Laredo, March 1903, *Reverchon 3726.* Hidalgo County: 3 miles south of San Manual, Jan. 1937, *H. B. Parks 21002;* 5 miles north of Mission, March 1936, *H. B. Parks 18002.* MEXICO. CHIHUAHUA: pass between Chilicote Station and Las Animas, Sept. 1938, *Johnston 7996.* SAN LUIS POTOSI: region of San Luis Potosi, 1878, *Parry & Palmer 18;* 49 miles northeast of San Luis Potosi, Sept. 1938, *Johnston 7504.* COAHUILA: valley near Saltillo, Jan. 1847, *Gregg* (Gray, type); Saltillo, May 1898, *E. Palmer 175;* Parras, June 1880, *E. Palmer 45.* TAMAULPAS: San Fernando-Jimenez, Feb. 1902, *E. W. Nelson 6609.* HIDALGO: Ixmiquilpan, July 1905, *Rose et al. 8914.*

1b. SYNTHLIPSIS GREGGII var. **hispidula** var. nov.

Siliquis hispidis; replo obovato vel oblongo.—San Miguelito Mountains, San Luis Potosi, Mexico, 1878, *J. G. Schaffner 149* (Gray, type).

Siliques hispid with rough stalked trichomes; replum shorter and broader than in var. *typica.*

SPECIES EXCLUDED FROM SYNTHLIPSIS

Synthlipsis lepidota Rose, Contrib. U. S. Nat. Herb. 8: 294. 1905 = *Lesquerella argentea* (Schauer) Watson, Proc. Am. Acad.

23: 252. 1888 (See Payson, Ann. Mo. Bot. Gard. 8: 140. 1921).

Synthlipsis Berlandieri Gray, Bot. Mex. Bound. Surv. 34. 1859 = *Lesquerella lasiocarpa* (Hook.) Watson, var. *Berlandieri* (Gray) Payson, *op. cit.* 139.

Synthlipsis Berlandieri Gray, var. *hispida* Watson, Proc. Am. Acad. 17: 321. 1882 = *Lesquerella lasiocarpa* (Hook.) Watson.

Synthlipsis heterochroma Watson, *l. c.* = *Lesquerella lasiocarpa* (Hook.) Watson.

STANLEYELLA

Stanleyella Rydb., Bull. Torr. Bot. Club 34: 432. 1904.

Stanleyella texana (Cory) comb. nov.

The plant described by Cory as *Sisymbrium texanum* (Rhodora 39: 418. 1937) is not a member of that genus. Rather it must be referred to the genus *Stanleyella* which up to now has been monotypic. *Stanleyella texana* differs from members of *Sisymbrium* in having accumbent cotyledons, reflexed or spreading sepals at anthesis, very slender petals which are not effectively differentiated into blade and claw, filaments of nearly equal length which exceed the long petals, nectar glands almost equally developed under all filaments and a congested inflorescence and fruiting raceme. The following specimens not cited by Cory belong to this species. TEXAS. Brewster County: Terlingua Creek, northeast of Agua Fria, April 1936, *Cory* (Gray); north of Terlingua, April 1938, *Warnock 309* (U. S. Nat. Herb.); near Hot Springs, March 1938, *Sperry 1288* (U. S. Nat. Herb.).

Gray Herbarium, Harvard University,
February 14, 1939.

REVIEW

The Flowering Plants and Ferns of Mount Rainier. BY GEORGE NEVILLE JONES. University of Washington Publications in Biology. Volume VII. Pp. 1–192 with 9 plates. University of Washington, Seattle, 1938. Price $1.75, obtainable from the Publications Editor.

A thoroughly worthy companion volume to his excellent "Botanical Survey of the Olympic Peninsula," the present work gives a detailed picture of the flora of the Mount Rainier section of the Cascade Range. The book is intended for amateur as well as professional botanists, and is provided with concise and readily usable keys to the families, genera, species and varieties. Each of these entities is, in turn, equipped with a skeleton description and an indication of habitat and life zone preference. The all too brief introduction affords an analysis of the flora, by application of the Raunkiaer spectrum combined with the life zone hypothesis. No comparison is offered of the Olympic and

Cascadian floras, a comparison which, although not necessarily within the scope of the paper, might afford some exceedingly significant data. The generic concept employed is conservative throughout; the specific is somewhat less conservative, and five new species are described. The most exhaustive account of any portion of the Cascade Range which has yet been published, this volume will be a necessary and welcome addition to the working library of every plant student of the Pacific Northwest.—L. C.

NOTES AND NEWS

TEUCRIUM GLANDULOSUM IN CALIFORNIA AND ARIZONA. A specimen which was provisionally referred to *Teucrium glandulosum* Kellogg by T. H. Kearney was collected in the Castle Dome Mountains, Yuma County, Arizona at Horse Tanks in May 1938 by A. A. Nichol. The specimen was referred to me and because of the large size of the corolla, the lower lip being 2 cm. long, there was an element of doubt as to its identity. However, in July of the present year, I visited the locality and found the plant locally abundant near the Tanks in small arroyos and in the main drainage bottom above the Tanks. It is a diffuse plant, as much as a meter tall. Both flowers and mature fruit were present which, being compared with an abundant collection made this year on Cedros Island by Haines and Hale, leaves no doubt as to its specific identity. Nichols' collection with large flowers was made at the very beginning of the season. As the season progressed the flowers had grown smaller until by its end they were half the former size. This species has heretofore been known only from Cedros Island, where it occurs in the *Larrea* formation, and on the adjacent peninsula. To find it in Arizona was not without interest. This interest was doubled by its discovery in May of the present year in the Whipple Mountains of San Bernardino County, California, by Miss Annie M. Alexander. It was collected there among rocks in shady moist places at an altitude of 1450 feet on the Gene Reservoir to Copper Basin road. Since a number of exotics have been found at Horse Tanks the possibility was present that it had been introduced. Its habit of occurrence there as well as its discovery in the Whipple Mountains suggest otherwise. The specific epithet arouses wonder, for the plant is quite glabrous and in no way glandular.—CARL EPLING, Department of Botany, University of California at Los Angeles.

Dr. F. W. Foxworthy, Research Associate in Botany, University of California, published his second general treatise on Philippine Dipterocarpaceae in the Philippine Journal of Science in 1918 (13 c: 163–200). The third appears in the same journal an even twenty years later (Philipp. Jour. Sci. 67: 241–333, pls. 1–9. 1938) and embodies the results of the author's constant attention to the family, and of a large amount of publication by others during recent years. Although five species are described as new, the total number recognized drops from seventy to fifty-one. The family is *the* source of lumber from Celebes to India constituting almost the whole of the Philippine export, more than fifty million board feet annually, and an almost corresponding amount is locally consumed.—E. B. C.

"Genera Hymenophyllacearum," by Edwin Bingham Copeland has been received recently (Philipp. Jour. Sci. 67: no. 1, 1–110, pls. 1–11. September, 1938). In this important contribution to the literature of Pteridophyta by Dr. Copeland, Research Associate in Botany, University of California, thirty-three genera are recognized. A general discussion of the family is presented together with keys to the genera, descriptions, and a diagram illustrating generic relationships. Species of each genus are listed with ranges. Generic synonyms under each genus and a useful index of specific synonyms are included. The plates illustrate genera not illustrated in the author's previous treatises of *Hymenophyllum* and *Trichomanes*.—E. Crum.

The following important publications in the field of taxonomy have appeared recently: "Index to North American Ferns. Constituting a catalogue of the ferns and fern allies of North America, north of Mexico, including all known forms, varieties and hybrids," by M. Broun (217 p., Orleans, Massachusetts. 1938); "The generic segregation of the Sequoias," by J. T. Buchholz (Amer. Journ. Bot. 26: 535–538. 1939); "Perennial lupines of the Pacific states," by Alice Eastwood, I. (Leafl. West. Bot. 2: 146–156. 1939), II. (op. cit. 2: 180–183. 1939); "A Revision of Salvia: subgenus Calosphace," by C. Epling, I. (Repert. Spec. Nov. Fedde Beih. 110, pt. 1: 160 pl. xvi. 1938), II. (op. cit. 110, pt. 2: 161–380. pl. xvii–xxxiii, maps 17–33. 1939); "A Flora of California," by Willis Linn Jepson (Vol. 3. pt. 1, Lennoaceae to Convolvulaceae, pp. 17–128, figs. 280–365. 1939); "A Revision of Besleria," by C. V. Morton (Contr. U. S. Nat. Herb. 26: 395–474. 1939); "The cruciferous genus Stanleya," by R. C. Rollins (Lloydia 2: 109–127. 1939); "Distributional notes on and a key to the species of Cheilanthes in the Sonoran Desert and certain adjacent regions," by I. L. Wiggins (Amer. Fern Journ. 29: 59–69. 1939).

On October 6, 1939, there appeared "An Illustrated Manual of California Shrubs," by Howard E. McMinn, Professor of Botany, Mills College, Oakland, California. The exact date of publication was inadvertently omitted and is here recorded for the purpose of calling attention to the effective date of publication of nomenclatorial changes.—H. L. M.